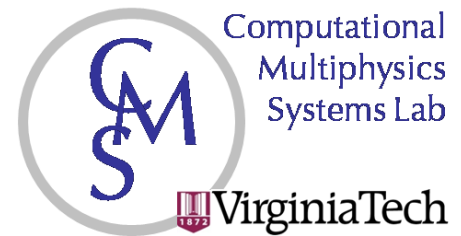# Reliability-Enhanced Robots with Map-based Teleoperation and Semi-Autonomous Capabilities
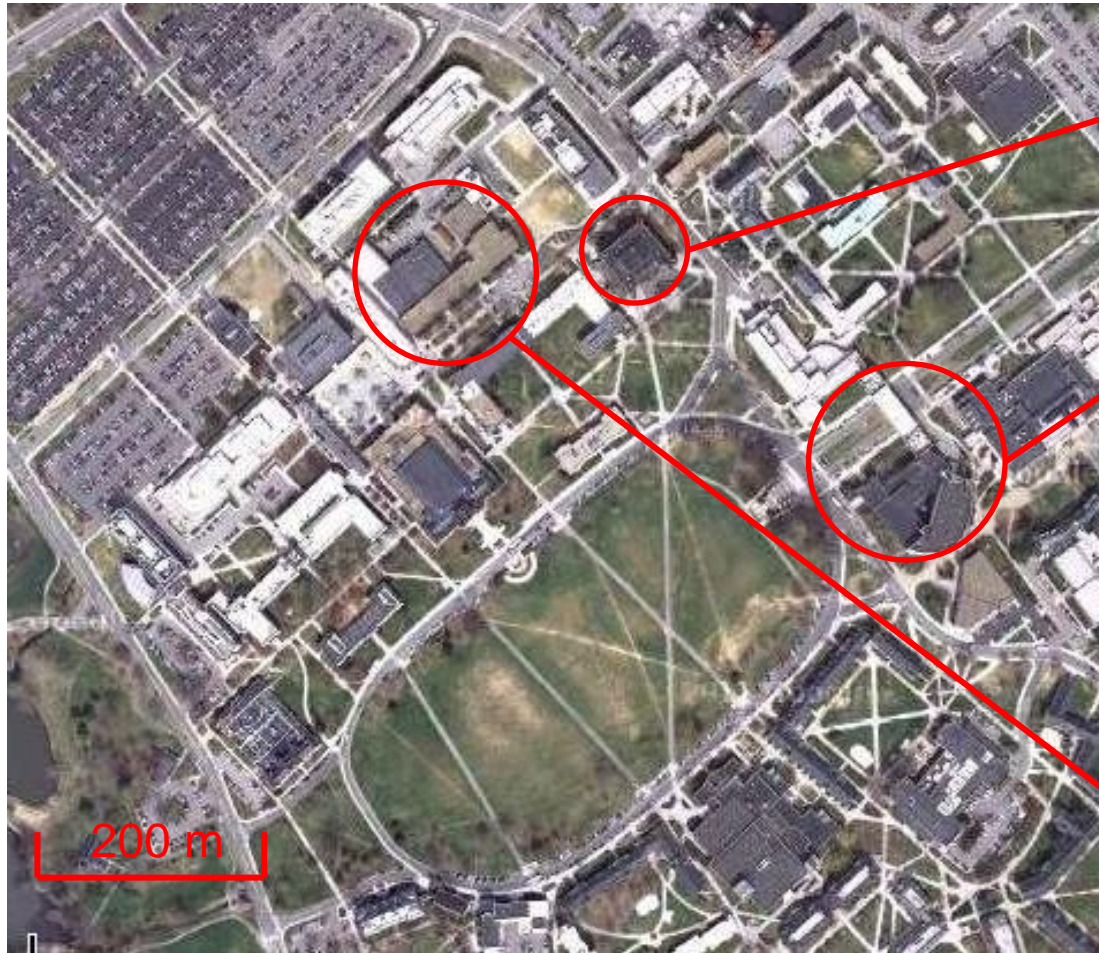
Tomonari Furukawa

Virginia Center for Autonomous Systems (VaCAS)

Virginia Polytechnic Institute and State University (Virginia Tech)

Gamini Dissanayake and Jaime Valls Miro

Center for Autonomous Systems (CAS)

University of Technology, Sydney

Computational Multiphysics Systems Lab

VirginiaTech

Computational Multiphysics Systems Lab

VirginiaTech

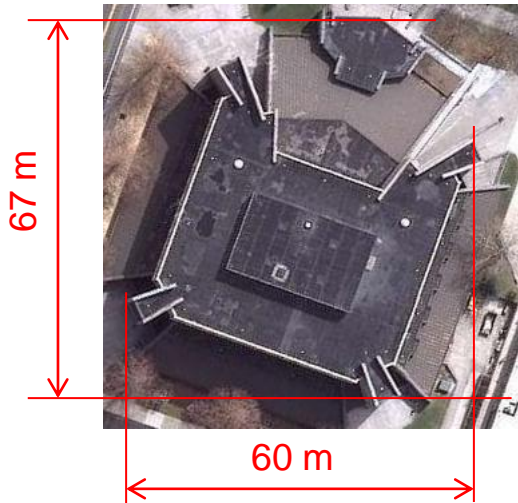Virginia Tech campus (Blacksburg, VA)

McBryde Hall

Newman Library

Randolph Hall

Challenge:
- Large (100m x 100m)
- Complex (Rooms/corridors)
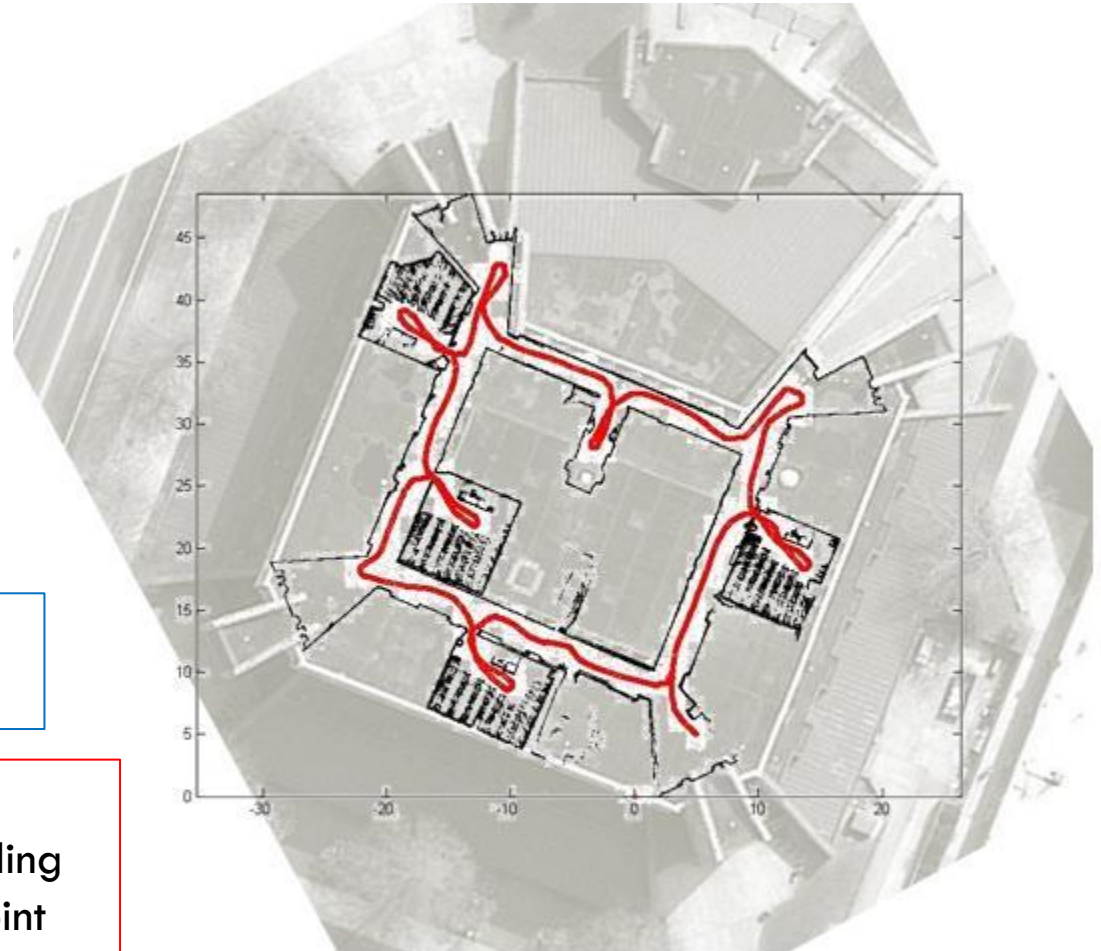- Practical (Existing bldgs)

Result at McBryde Hall

Computational Multiphysics Systems Lab
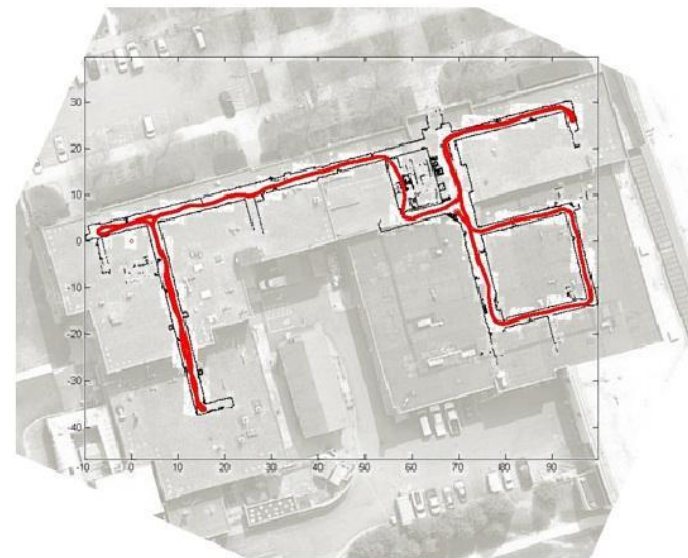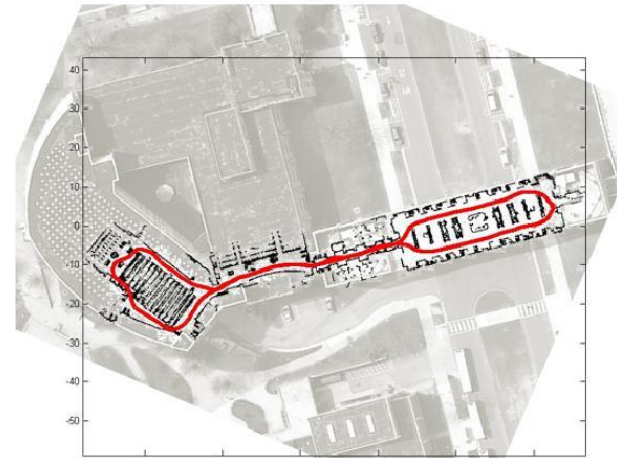
VirginiaTech

67 m

60 m
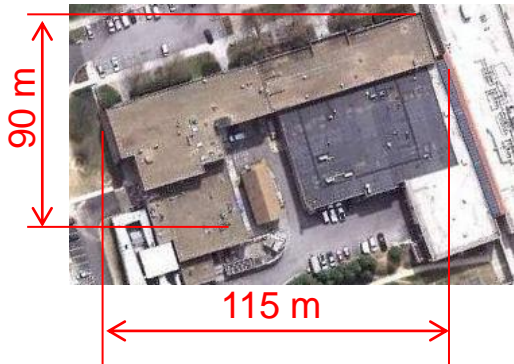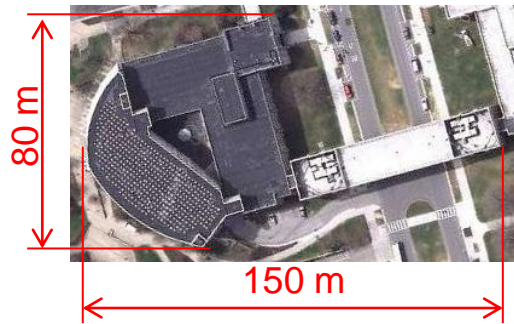
Challenge:
Long loop corridor (120m)

Result:
10cm/0.5deg error after traveling
235m without revisiting start point

Results at Two Other Buildings

Challenge:
- Larger areas (100m x 100m)
- Long open-loop corridors

Result: 5cm/0.5deg error

Environments to Monitor

Fukushima power plants
- GPS-denied
- Dark
- Humid
- Unreliable communication (1m wall thickness)

Issues of robot use:
- Two weeks training
- Camera may not be usable
- Wires could get jammed

Immediate use of robotics technology:
- Map-based teleoperation in camera/GPS-denied environments
- Semi-autonomous return in communication denied environments

Packbot in Fukushima power plant
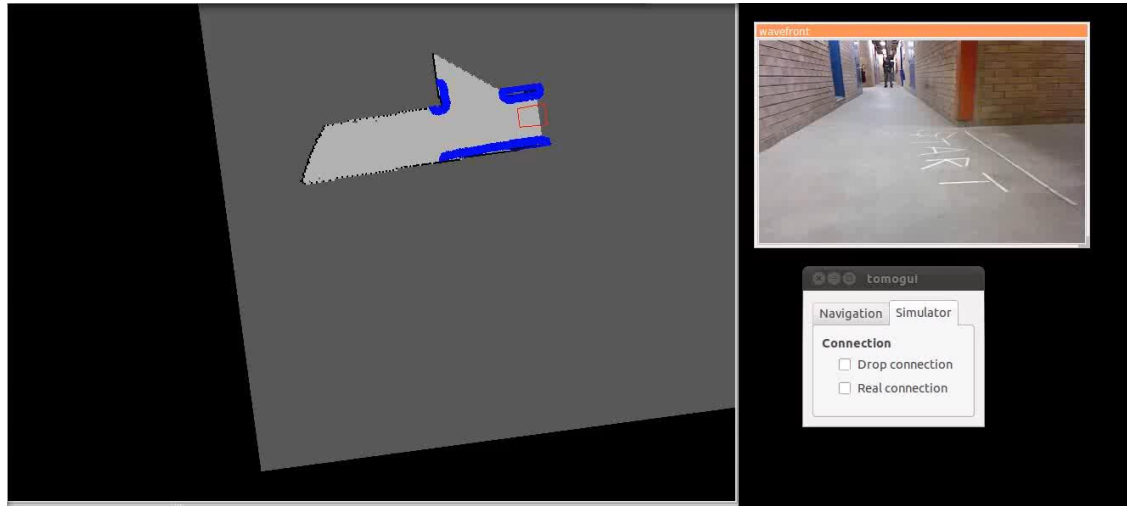(source : Reuters/TEPCO)

Nuclear Disaster Robots
Map-based Teleoperation and Semi-autonomous Return

Computational
Multiphysics
Systems Lab

VirginiaTech

Returning to starting position

CMS Lab
Virginia Tech

GUI for map-based teleoperation

Map-based teleoperation

Semi-autonomous return

Reliability-enhanced robots

- Use of robot in use at Fukushima power plant
- Use of accurate Simultaneous Localization and Mapping
  - Grid-based Scan-to-Map Matching SLAM
  - Map accuracy with less than 0.01% error

Semi-autonomous robots for nuclear power plants

- Map-based teleoperation in GPS-/camera-denied environments
- Semi-autonomous return under communication loss

Further achieved work

- 3D road inspection
- 3D bridge inspection